HEAD AND MOUTH-PARTS OF MECOPTERA.

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INTRODUCTION.

Our knowledge of the head and mouth-parts of the Mecoptera is fragmentary. Nothing comprehensive has been published dealing with the study of a collection of genera and species representative of the entire order. It was with the object of contributing to our knowledge of the morphology of the head and mouth-parts of the Mecoptera and to invite further investigation on the subject that this study was undertaken.

In order to make the work as comprehensive as possible, an attempt was made to study as many species as could be obtained, representing the different genera. Comstock, in his Manual for the Study of Insects, recognizes only one family of Mecoptera, the family Panorpidæ. In his paper on the Panorpidæ of America North of Mexico, Hine (1901) listed five genera, namely: *Merope*, *Boreus*, *Panorpodes*, *Panorpa* and *Bittacus*, dividing these into two groups, those with ocelli in one group and those without in the other. *Merope* and *Boreus* were placed in the first group and *Panorpodes*, *Panorpa* and *Bittacus* in the second. In a recent monograph of the Mecoptera, Esben-Petersen (1921) lists five families, namely: Bittacidæ, Boreidæ, Panorpidæ, Natiothaumidæ and Meropidæ. I have been able to study all of the genera listed by Hine. This comprises all of the families in Petersen's monograph with the exception of one, the family Natiothaumidæ, which like the family Meropidæ, includes only one species (*Natiothauma reedi* MacLachlan) and this is known to exist only in Chile and is very rare.

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METHODS.

The specimens of the head of the different species were treated for a few minutes with a five per cent solution of hot potassium hydroxide. Before being examined they were washed with distilled water and then transferred to 70% alcohol. All dissections and examination were made in alcohol under a binocular microscope. Parts with minute details were mounted temporatily on slides and studied under a compound microscope. An ocular eyepiece micrometer ruled in squares proved helpful in getting the proportions for the drawings.

FIXED PARTS OF THE HEAD.

The order Mecoptera is referred to by taxonomists as having the head prolonged into a trunk-like beak at the end of which are located the biting mouth-parts. An examination of the head of the various species studied shows that *Panorpodes* (Figs. 1, 17, 27) does not conform to this characterization of the order. It is very much orthopteran in form and is the most generalized of all the genera studied and has been taken as the type. *Panorpa* (Figs. 10, 24, 31) and *Boreus* (Figs. 14, 26, 32) are the only genera that possess a trunk-like beak and are the most specialized, *Boreus* being more so than *Panorpa. Bittacus* (Figs. 3, 19, 28), *Aptero-bittacus* (Figs. 5, 23, 29) and *Merope* (Figs. 7, 25, 30) are intermediate in form. It should be mentioned, however, that specialization is not monopolized by either *Boreus* or *Panorpa. Merope,* for example, is without ocelli and in this respect is more highly specialized than either *Boreus* or *Panorpa.*

The epicranial suture is undoubtedly the most important landmark on the head capsule of insects. In a discussion of the sclerites of the head, therefore, it is logical to begin with this suture. This suture is the inverted Y-shaped median stricture found in nymphs, larvæ and generalized adult insects. It marks the line of closure of the head during embryonic development. Originating at the occipital foramen, it extends along the dorso-meson for some distance and gives rise to two branches known as the epicranial arms. Each arm extends toward a compound eye in generalized adult insects and to the cephalic margin of the head in the case of larvæ. The stem of the epicranial suture, designated as the epicranial stem, is obsolete in all the species of Mecoptera studied. In a hypothetical type of the mecopterous head, the epicranial stem, as in generalized insects, originates from the occipital foramen and extends cephalad and ventrad along the meson and is interrupted at some point by the median ocellus. Emerging, still as a single suture from the ventral margin of the median ocellus, the epicranial stem extends ventrad of the antennariæ, where it divides into the epicranial arms, each arm extending laterad to a pretentorina and then ventrad, terminating in a precoila. In *Panorpodes* (Fig. 1), the epicranial arms (ea) are only partially present and the portion of each arm extending from a pretentorina (pn) to a precoila (pr) is obsolete. In *Bittacus* (Fig. 3), the entire epicranial arms are present and in this respect *Bittacus* is more generalized than *Panorpodes*. In *Apterobittacus* (Fig. 5), the transverse portion of the arms connecting the pretentorinæ has disappeared. In *Merope* (Fig. 7), the entire epicranial suture is obsolete. In *Panorpa* (Fig. 10), on the other hand, a portion of the arms is present and is, therefore, in this particular more generalized than *Merope*. In *Boreus* (Fig. 14), the same condition as in *Merope* obtains, the complete obsolescence of the epicranial suture.

The vertex (V, Figs. 1, 6, 14, 16, 19, 27, 28) extends from near the occipital foramen (of, Figs. 16, 19, 22) and ventrad to the sutures marking the boundary of the sclerites of the ventral portion of the head. In generalized insects, as the cockroach, the vertex is a paired sclerite, being divided along the meson by the epicranial stem. The vertex in the Mecoptera is a solid piece, not a paired sclerite, on account of the obsolescence of the epicranial stem. It bears, besides the compound eyes, the ocelli and the antennæ (a). Each lateral portion of the vertex is greatly prolonged ventrad in *Boreus* and *Panorpa*. There is a tooth-like lateral projection of the vertex in *Bittacus*, *Apterobittacus*, *Merope* and *Panorpodes* which is especially prominent in the species of the last named genus. This projection seems to be wanting in *Panorpa* and *Boreus*, but its homologue can be identified in these last two genera.

The fronto-clypeus (fc), formed by a fusion of the front and clypeus through the obsolescence of the fronto-clypeal suture, is, roughly speaking, subquadrate in *Panorpodes* (Fig. 1), *Bittacus* (Fig. 3), *Apterobittacus* (Fig. 5), and *Merope* (Fig. 6), and rectangular and greatly elongated in *Panorpa* (Fig. 10) and *Boreus* (Fig. 14). It is in general

setiferous and is fused with the labrum (l) in all the species studied. Its ventral extent, however, is marked by the position of the precoilæ (pr). In *Merope* and *Boreus*, the fronto-clypeus has completely merged with the vertex owing to the obsolescence of the entire epicranial suture; in *Bittacus*, the fronto-clypeus is wholly separated from the vertex by the epicranial arms, and in *Apterobittacus*, the fronto-clypeus is fused with the vertex along its dorsal margin owing to the obsolescence of the transverse portion of the epicranial arms, whereas in *Panorpodes* it is fused with the vertex along its lateral margins, brought about by the disappearance of the lateral parts of the epicranial arms.

There is a pair of membranous areas dorsad of the fronto-clypeus which connect the antennæ and the head (Fig. 1). These are the antacoriæ (an) and are located on the vertex in the Mecoptera. The size of the antacoriæ in the Mecoptera varies considerably, being smallest in *Bittacus* and most pronounced in *Panorpodes*. Surrounding each antacoria is a narrow, ring-like sclerite known as the antennaria (ar). There is a cuticular projection into the antacoria from the ventro-lateral portion of the antennaria, which is somewhat prominent in *Panorpa* (Fig. 31) and *Boreus* (Figs. 14, 32), designated as the antacoila (aa). Yuasa (1920) referred to the antacoila as being the "chitinized pin" in the cockroach, as described by Miall and Denny.

The compound eyes (ce), regarded as the appendages of the first, ocular or protocerebral segment are of considerable size in the Mecoptera and are especially prominent in *Bittacus* (Figs. 3, 28) in proportion to the size of the head. Viewed from the lateral aspect, the compound eyes are oval except in *Merope* (Figs. 7, 30), where they are oblong and emarginate on the cephalic margin, giving them a distinctly reniform shape, thus resembling the eyes of some Hymenoptera, as *Vespa maculata*. In *Bittacus* the eyes are slightly emarginate on the caudal margin, the reverse of *Merope*, giving the eyes also a kidney-shaped appearance. Each compound eye is surrounded by a narrow ring-like area, which is prolonged entad as an annular strongly chitinized plate. This area is called the oculata (ol) and was designated by Comstock and Kochi (1902) as an "ocular sclerite." These authors considered the oculata as the proximal segment of an ocular appendage. Crampton (1921), however, is not inclined to consider the oculata as a sclerite, stating that this area is not marked off by a true suture and objects to the consideration of the oculata by Comstock and Kochi as being the basal segment of an ocular appendage. Yuasa (1920) observed the oculata as being always present in all the species of Orthoptera which he studied and as well developed in the species having large compound eyes, as *Mantis religiosa* and *Melanoplus differentialis*. Peterson (1916) likewise recognized the oculata in Diptera and calls it the ocular sclerite, using the term proposed by Comstock and Kochi.

The normal number of ocelli is present in all of the genera studied, with the exception of *Merope*. They are more or less circular in outline and are most prominent in *Bittacus* and in *Apterobittacus*. They are located on the vertex as is true in all Entoptera. In *Bittacus* (Figs.

3, 28) and in *Apterobittacus* (Figs. 5, 29), the lateral ocelli (lo) are situated distinctly dorsad of the compound eyes, whereas they are mesad of the latter in the other genera where they are present. The ocelli are located on convex areas in *Panorpodes* (Fig. 1) and *Panorpa* (Fig. 10) and are close to each other in *Panorpa*. The median ocellus (mo) in all cases is slightly smaller than either of the lateral ocelli.

As stated previously, Hine (1901) divided the genera of the Panorpidæ into two groups, those with ocelli in one group and those without in another. *Merope* and *Boreus* were placed in the first group and *Bittacus*, *Panorpa* and *Panorpodes* in the other. In his monograph, as already referred to, Esben-Petersen (1921) divides the Mecoptera into five families, giving as one of the characteristics of the family Boreidæ to which *Boreus* belongs, the absence of ocelli. I found the normal number of ocelli present in the species of *Boreus* that I studied. The ocelli, however, were small and overshadowed by the black color and shiny appearance of the head, black with a bluish tinge. This is probably the reason why the ocelli in *Boreus* have been overlooked by previous workers. A few minutes' treatment of the head with a five per cent solution of potassium hydroxide will reveal the ocelli as circular, white opaque bodies. Each lateral ocellus is located near the dorso-mesal margin of a compound eye and the median ocellus between the antacoriæ (an). Judged from the location of the ocelli, *Boreus* is more specialized than any of the other genera.

There is a pair of depressions on the cephalic aspect of the head ventro-mesad of the compound eyes. These depressions are known as the pretentorinæ (pn), which mark the point of invagination of the pretentoria (pt, Figs. 37, 38, 39, 40). In *Panorpodes*, *Panorpa* and *Boreus*, the pretentorinæ are situated directly ventrad of the antacoriæ (an), while they are distant from the latter in *Bittacus*, *Apterobittacus* and *Merope;* they are, in these last three genera, near the ventro-mesal margin of the compound eyes and distinctly more so in *Bittacus* where they nearly touch the margin of the eyes.

In specialized insects, the pretentorinæ are not fixed in location. They may migrate away from the precoilæ (pr) but are usually located on or near the epicranial arms. In the Orthoptera, the pretentorinæ are located immediately dorsad of each precoilæ and are apparently distant from the epicranial arms. In the Mecoptera, they are isolated from the precoilæ and are markedly so in *Panorpa* and *Boreus*, owing to the great elongation of the fronto-clypeus.

The precoilæ (pr) in which the mandibles are articulated on the cephalic aspect are distinct in the Mecoptera. Each precoila is located at the ventro-lateral angle of the fronto-clypeus. In generalized insects, each precoila is situated at the caudo-lateral or dorso-lateral angle of the clypeus, depending upon the direction of the mouth-parts. In the honey-bee and other Hymenoptera, the precoilæ are similarly situated as in the Mecoptera. The clypeo-labral suture is obsolete in the Mecoptera studied.

The labrum (l) of *Panorpodes* (Fig. 1) is of considerable size, setiferous, narrower at tip, and each lateral margin is slightly emarginate.

The ventral margin is distinctly emarginate. That of *Bittacus* (Fig. 3) is elongated, narrows gradually ventrad and is slightly rounded at the apex. Its ventral half is fringed along the lateral margin with setæ, those toward the apex being rather prominent. The dorsal half of the lateral margin is thin and folded mesad (Fig. 52). The ventral portion of each lateral fold is also fringed with rather small setæ. The labrum of *Apterobittacus* (Fig. 5) is very similar to that of *Bittacus*. That of *Panorpa* (Fig. 10) is reduced on account of the great elongation of the fronto-clypeus. It is chordate in shape and its apical margin is emarginate. Each lateral margin is fringed with setæ, which are more prominent and are present in larger numbers than in *Bittacus*. *Boreus* (Fig. 14) has likewise a reduced labrum, which is rounded, fleshy and densely setiferous at the apical margin. The setæ of the distal margin are minute. The labrum of *Merope* (Fig. 7) has a bluntly pointed apex and its free margins are densely fringed with rather long setæ. The cephalic surface is also clothed with short setæ, an oblique row of such setæ being recognizable along each side of the meson.

In all the genera studied, the occipital foramen (of, Figs. 17, 19, 22), 24, 25, 26) is of considerable size and is divided into two parts by a strongly chitinized bridge designated as the corpotentorium (ct), or body of the tentorium. The dorsal or upper portion of the occipital foramen is larger than the ventral, with the exception of *Bittacus*, where they are almost of the same size. At each ventro-lateral margin of the dorsal portion of the occipital foramen is a strongly chitinized triangular projection known as an odontoidea (od), which serves as a point of articulation for a cervepisternum (ccs), a chitinized lateral sclerite of the cervix or neck which connects the head and the thorax. The membrane connecting the neck and the head is the cervicoria (cc). The odontoideæ are more prominent in *Panorpa* and *Panorpodes* than in *Bittacus*, *Apterobittacus* and *Boreus*. They can hardly be identified in *Merope*.

That part of the head adjacent to the occipital foramen and dorsad of the odontoideæ is known as the occiput (oc). In some insects, as in the grasshopper (*Melanoplus differentialis*) the occiput can be differentiated because of the partial presence of the occipital suture. It is divided along the meson by the epicranial stem. In all the mecopterous insects studied, the occiput is merged with the vertex owing to the obsolescence of the occipital suture.

In the Orthoptera, as in the grasshopper, there are two distinct sclerites, known as the postgenæ (pa), ventrad of the occiput, one on each side of the occipital foramen. In the same insect, there is a transverse suture which separates the occiput and a postgena. The suture in question is designated as the occipito-postgenal suture. In the mecopterous heads studied, the postgenæ are continuous with the vertex and occiput. In the absence of the occipito-postgenal suture, the odontoideæ may be used as landmarks in determining the point of division between the occiput and each postgena. In all the species treated in this paper, the postgenæ are of considerable size and in *Boreus* and *Panorpa*, they are prolonged ventrad as a narrow area.

At the apical margin of each postgena is a distinct acetabulum, a coila, known as a postcoila (ptl) in which the caudo-proximal portion of each mandible is articulated. The postgenæ in all the species of Mecoptera studied extend mesad and fuse on the meson, forming a bridge, known as the genaponta (gn), which limits the ventral extent of the occipital foramen. The genaponta in *Boreus* (Fig. 26) is a large area, whereas it is very narrow in the other genera.

In *Blatta* and other Orthoptera, the tentorium consists of the following parts: metatentoria, carpotentorium, pretentoria, laminatentorium and supratentoria. The tentorium in the Mecoptera (Figs. 37, 38, 39, 40) is not as well developed as in the Orthoptera. All of the typical parts of the tentorium mentioned above, except the laminatentorium, are present in the Mecoptera. The metatentoria (mt) support the lateral margins of the occipital foramen and are prolonged mesad, fusing into a strongly chitinized bridge known as the carpotentorium (ct) or body of the tentorium, and which, as has been stated previously, divides the occipital foramen into two portions. The points where the metatentoria are invaginated are the metatentorinæ (mn); as a rule they are not very distinct in the species of Mecoptera studied. The pretentoria (pt) or anterior arms of the tentorium connect the caudal and the cephalic aspects of the head. The places of invagination of the pretentoria are the pretentorinæ (pn), which have been described elsewhere. Arising from each pretentorium and connecting the latter with the ental portion of each lateral margin of an antennaria is a supratentorium (st). The supratentorium are best developed in *Bittacus* and *Apterobittacus* and are hardly distinguishable in *Panorpa* and *Panorpodes* where they are thread-like.

MOVABLE PARTS OF THE HEAD.

The antennæ are usually long, setiferous and multiarticulated in the Mecoptera. The antenna of *Boreus* (Fig. 35) is filiform and consists of twenty-three segments. Those of *Panorpodes* and *Panorpa*, like those of *Boreus*, are filiform and consist of a larger number of segments. *Bittacus* (Fig. 33) has a setaceous antenna consisting of about twenty segments. The antennæ of *Merope* (Fig. 34) are very different, moniliform, there being twenty-nine segments.

The mandibles of all the species studied are decussating. Those of *Panorpodes oregonensis* (Figs. 20, 21) are triangular and are provided with two distadentes (dd), the distal one being more prominent. The mesal margin is irregularly serrated. The mandibles of *Panorpodes carolenensis* (Figs. 15, 23) differ somewhat in shape and the distadentes are not as prominent. The mesal serration is more regular than that of *oregonensis*. Those of *Merope* (Figs. 9, 18), *Panorpa* (Figs. 11, 12), and *Boreus* (Figs. 4, 11) do not differ very much in shape from those of the two species of *Panorpodes*. Unlike those of *Panorpodes*, they are not serrated along the mesal margins. The mandibles of *Merope* and *Panorpa* are each provided with three distadentes, the lateral one being the most prominent and is especially well developed in *Merope*, and the mesal tooth the smallest. Hine (1901) gave as one of the characteristics

of the genus *Panorpa* the two-toothed condition of the mandibles. Examination of the mandibles of *Panorpa americana* and *Panorpa lugubris* shows that they are distinctly three-toothed. The mandibles of *Merope* are slightly emarginate at the middle of the mesal margin. Those of *Boreus* are six-toothed, the teeth decreasing in size toward the proximal portion of the mandible. *Bittacus* (Figs. 2, 8) has a distinctly different type of mandibles. They are greatly elongated, sword-shaped, and end in a prominent distadentis. There is also a rudimentary mesal tooth. At the meso-proximal portion of each mandible, there is present a conical projection, the function of which is not clear. Hine (1898), in his paper on the genus *Bittacus* failed to notice this, as may be judged from his descriptions and figures. The mandibles of *Apterobittacus* (Figs. 6, 16) are very much like those of *Bittacus*. In all the mandibles of the Mecoptera here considered, there is a prominent swelling on the caudo-proximal portion, a condyle, known as the postartis (ptc), which articulates in a distinct acetabulum of the postgena, the postcoila (ptl, Figs. 50, 52, 59). Each mandible articulates on its cephalic aspect to the precoila of the clypeus by means of another condyle known as the preartis (py). The tendons, to which the muscles of the head are attached, controlling the movement of the mandibles, are well developed. The lateral tendon, which is the smaller of the two, and to which the extensor muscles are attached, is known as the extensotendon (et), and the mesal tendon, to which the retractor muscles are attached, is called the rectotendon (rt).

The maxillæ are well developed in the Mecoptera. The maxillæ of *Panorpodes oregonensis* (Fig. 49) and *P. carolenesis* (Fig. 45) are very similar and they represent the most generalized condition of all the species examined. The maxillæ of *Boreus* are the most specialized owing to the fact that they are completely fused with the labium. The cardo (ca) in all the species is undivided and is strongly chitinized. In both species of *Panorpodes*, the cardo is triangular and with a few prominent setæ at ventro-lateral angle. It is also triangular in *Panorpa* and is provided with a few small setæ, whereas it is subquadrate in *Bittacus* (Fig. 41) and *Apterobittacus* (Fig. 44) and the setæ, as in *Panorpodes*, are prominent. The two cardines in *Merope* (Fig. 46) are club-like in outline and there is in each cardo a prominent projection on its ventro-mesal margin. The cardines in *Boreus* (Fig. 36) are fused and together with a part of the submentum form a somewhat elliptical plate. The stipes (s) is also strongly chitinized, generally club-shaped; in *Panorpodes*, *Bittacus*, *Apterobittacus* and *Panorpa* and with prominent setæ. As has been already stated, the maxillæ of *Boreus* are fused with the labium so that it is impossible to ascertain the mesal extent of the stipes. The stipes (s) in Merope (Figs. 46, 47) are broad and fused at the proximal end. There are two prominent lobes distad of the stipes in all the species. The outer or lateral lobe has been designated by other workers, among whom are Hine, Miyake and Crampton, as the galea and the inner or mesal lobe as the lacinia. In nearly all the species studied, the so-called lacinia is always the larger and the better developed of the two lobes, which is an anomaly,

considering the condition existing in other specialized insects. By virtue of the position of the lobes, these designations are logical, the part adjacent to the maxillary palpus is always the galea. In highly specialized insects, as the Diptera, the lacinia is in nearly all cases wanting and where it is present, as in *Simulium* and *Tabanus*, as Peterson has shown, it is greatly reduced and the question may be raised as to whether this is even the lacinia. In most Hymenoptera, the lacinia is greatly reduced and in certain cases, as MacGillivray has shown, the lacinia may be absent. He has also shown that in many species of Hymenoptera, as *Macroxyela infuscata*, *Dolerus unicolor*, *Ophion bilineatum* and *Vespa maculata*, the galea is divided into two lobes. This divided condition of the galea is what probably obtains in the Mecoptera; the two lobes represent subdivisions of the galea while the lacinia has completely disappeared. The lobes of the galea (gl) in *Panorpodes oregonensis* (Figs. 49, 58) are finger-like and setiferous and they are of about the same length. In *Panorpodes carolinensis* (Fig. 45) the outer lobe of the galea is distinctly shorter. In *Bittacus* (Figs. 41, 43) and *Apterobittacus* (Figs. 44, 53), the two lobes are greatly elongated, and the inner lobe is even longer than the stipes. In *Merope* (Figs. 46, 54), the two lobes have assumed the form of strongly chitinized triangular plates with dense brushes of rather long setæ. The mesal margins of the lobes are thick, somewhat fleshy and with numerous minute setæ. Figure 55 shows the lateral aspect of the two lobes in *Merope*. The brush presents a U-shaped appearance. In *Panorpa* (Figs. 42, 47) and *Boreus* (Figs. 36, 60), the lobes have been reduced in length owing to the greatly elongated stipes. In *Panorpa* they are of about the same size and are setiferous. In *Boreus* the inner lobe is fleshy, setiferous and provided with two rows of strong conical spines arranged diagonally at the proximal end. The outer lobe in *Boreus* is a triangular plate curved mesad.

The maxillary palpus (mp) is five-segmented and setiferous in all the species. The palpifer (pf) is chitinous in *Panorpa*, membranous in *Bittacus* and *Apterobittacus* and slightly so in *Boreus* and continuous with the first or proximal segment of the maxillary palpus. In *Panorpodes*, the palpifer cannot be differentiated; it is probably merged with the stipes. The maxillary palpi of *Boreus* differ markedly from those of the other species studied in that the segments increase in diameter distad, the distal segment being not only the broadest but also the longest.

The maxillæ in general are not articulated to the paracoila of the head by a parartis. They are merely connected with the head by means of the maxacoriæ (mc) which are distinct in all the species.

The labium (li) consists typically of the following parts in generalized insects: submentum, mentum, and ligula, the latter of which consists of the stipulæ, glossæ, paraglossæ, palpigers and labial palpi. The mentum is in most cases small, completely fused with the stipulæ and cannot be identified as a separate sclerite. In both species of *Panorpodes* (Figs. 45, 49), the area between the stipes and cardines is entirely membranous. This area comprises the submentum (sm)

and the labicoriæ (lc), the membranes which connect the maxillæ and the labium in all generalized insects where the submentum is a distinct sclerite. In *Panorpa americana* (Fig. 48), the submentum is membranous except the ventral portion, which is distinctly chitinized. This chitinized portion of the submentum was designated as the mentum by Crampton (1921) in his figure for *Panorpa lugubris*, not indicating, however, the submentum. I have also examined specimens of the labium, as well as other parts of the head, of *Panorpa lugubris* and have not found marked morphological differences between it and that of *Panorpa americana*. The labicoriæ of *Panorpa americana*, as in *Panorpodes*, are continuous with the submentum. In *Bittacus* (Fig. 19) and *Apterobittacus* (Fig. 44), the chitinized portion of the submentum (sm) is an elongate area, vase-like in outline and bears long, prominent setæ. The ventral portion of this area was likewise designated by Crampton (1921) in his figure for *Bittacus* (species not indicated), as the mentum, labeling the dorsal portion of it as the submentum. Hine (1898) in his figure of the labium of *Bittacus strigosus*, showed the area between the stipes and cardines, considered as the submentum and labicoria in this paper, as if it were wholly setiferous and failed to indicate the chitinized area, which is rather distinct. Hine further considered the ligula as being absent. In *Merope* (Fig. 46), the submentum (sm) and labicoriæ have become strongly chitinized, except the portion between the cardines. In *Boreus* (Fig. 36), the area has become completely chitinized and fused with the stipes. We have thus in the Mecoptera a modification of this area from a wholly membranous to a wholly chitinized condition and also a condition where the maxillæ are distinctly differentiated from the labium in one case and another where they are distinctly continuous with it.

There is a subquadrate area distad or ventrad of the submentum which consists of the fused stipulæ, palpigers, glossæ and paraglossæ. This area is here designated as the mecaglossa, because it is typical of the Mecoptera. The palpigers (pp) are represented in all the figures as occupying the distal portion of the mecaglossa and include the somewhat membranous areas at the proximal ends of the labial palpi. Crampton (1921) calls the mecaglossa in *Panorpa lugubris* the palpigers, although, he says, they may represent the basal segments of the labial palpi. In his figure of the labium of the same species, he shows a distinct suture between what he calls the palpigers. Besides *Panorpa americana*, I have also examined numerous specimens of the labium of *Panorpa lugubris* and I was unable to find a suture dividing what he terms the palpigers. What appears to be a suture is a thickening formed by the fusion of the tendons which control the movement of the labial palpi. There is a depression along the region he indicates, but it is such a broad depression that it can not be called a suture.

The mecaglossa is very different from the stipulæ, glossæ and paraglossæ of generalized insects where there is a palpiger attached to the lateral margin of each stipula. It is a greatly reduced area in the Mecoptera and the palpigers are distal in position. The obsolescence of the sutures separating the glossæ and paraglossæ from the stipulæ and

the marked reduction of the mecaglossa as a whole has misled most authors in considering the mecaglossa as the palpigers.

The labial palpus (lp) in all of the species is two-segmented. The first segment in most cases is broad and fleshy, especially in the case of *Panorpa* (Fig. 48). At the base of the first segment of the labial palpus of *Panorpa* there is a chitinized plate which Miyake called the "basal piece." In his figure of *Bittacus*, and it is unfortunate that he did not indicate the species, Crampton (1921) shows, besides emphasizing it in the text, that each labial palpus is three-segmented. He makes some use of this condition in attempting to establish close relationship between the Neuroptera, Diptera and the Mecoptera. I have examined many specimens of the labium of *Bittacus strigosus* and found only two segments in the labial palpus. The distal segment is never divided as far as observed. Miyake figures two segments in *Bittacus nipponicus* and states for the Japanese Mecoptera as a whole: "The labial palpus is very conspicuous, consisting of two joints." Can it be that within the same genus the number of segments in the labial palpus varies to this extent or has Crampton made an error? Even in widely different genera of Orthoptera, the number of segments in the labial palpus is constant; it is always three. My specimen of *Apterobittacus* also shows a two-segmented condition of the labial palpus and this was formerly placed within the genus *Bittacus*.

The pharynx is defined as the portion of the alimentary canal extending from the occipital foramen to the mouth, the mouth being the opening surrounded by the mouth-parts. The pharynx has two main parts, a cephalic or ventral portion, depending on the position of the head, called the prepharynx, and a caudal or dorsal portion called the postpharynx (pox) which is always tubular. The prepharynx includes the epipharynx, hypopharynx and other parts. The size of the epipharynx (ex) varies with the size of the labrum, which in turn varies with the size and shape of the head. It is greatly reduced in *Panorpa* (Fig. 61) and *Boreus*, owing to the greatly elongated frontoclypeus. The epipharynx (ex) in general has minute circular areas, which are most numerous in *Panorpodes* (Fig. 50). These circular areas are probably portions of taste organs, which Packard (1889) designated as the taste cups. They are also found on the labium and the maxillæ. In *Panorpa* (Fig. 61), there is an oblique row of minute setæ on each side of the meson and along each side of this row of setæ there is a group of the circular areas that have been referred to previously. The epipharynx in *Merope* (Fig. 59) is densely clothed with very minute setæ.

The hypopharynx (hx) in the Mecoptera is well developed, except in *Boreus*, where it is somewhat reduced. In general it is tongue-like in appearance and is setiferous. At the base of the hypopharynx, where it joins the labium, is located the opening of the salivary duct, called the salivos (so). The salivary duct can be easily identified in many of the species. It is very well developed in *Apterobittacus* (Fig. 53) and its striated condition is very apparent.

SUMMARY.

Of all the genera represented in this study, namely: *Panorpodes*, *Bittacus*, *Apterobittacus*, *Merope*, *Panorpa* and *Boreus*, the first one, *Panorpodes*, is the most generalized. The head is orthopteran in form and does not have a trunk-like beak. *Boreus* and *Panorpa* are the most specialized, *Boreus* being markedly more so than *Panorpa*. These genera are the only two that possess a distinctly trunk-like beak.

The order Mecoptera is commonly characterized as having the head prolonged into a trunk-like beak at the end of which are located the biting mouth-parts. This characterization of the order is inaccurate and somewhat misleading. The term "trunk-like beak" does not fit most of the genera and moreover, the only mouth-parts located at the end of the beak are the mandibles.

Certain sclerites of the head and mouth-parts are given new interpretations. The portions of the labium which have been regarded as the palpigers by some authors are designated as the mecaglossa, because it is typical of the Mecoptera. It comprises the fused stipulæ, palpigers, glossæ and paraglossæ. The labial palpus is always two-segmented. The two lobes, commonly regarded as a galea and a lacinia, are here considered as subdivisions of the galea.

The American species of Mecoptera offer no evidence confirmatory of the opinion of Crampton and Tillyard that the glossæ and paraglossæ of Peterson in the Diptera are homologous with the labial palpi.

The normal number of ocelli present is three. They are ordinarily large and subadjacent. The ocelli are wanting in *Merope*. Authors hitherto have described the ocelli as wanting in *Boreus*. I have found three small, distant inconspicuous ocelli in this genus.

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LIST OF ABBREVIATIONS.

a—antenna.
aa—antacolla.
af—antafossa.
an—antacoria.
ar—antennaria.
ca—cardo.
cc—cervicoria.
ccs—cervepisternum.
ce—compound eye.
ct—corpotentorium.
dd—distadentes.
ea—epicranial arm.
et—extensotendon.
ex—epipharynx.
fc—fronto-clypeus.
fl—flagellum.
hx—hypopharynx.
gl—galea.
gn—genaponta.
l—labrum.
lc—labicoria.
li—labium.
lo—lateral ocellus.
lp—labial palpus.
mc—maxacoria.
md—mandible.
mg—mecaglossa.
mn—metatentorina.
mo—median ocellus.
mp—maxillary palpus.
mt—metatentorium.
oc—occiput.
od—odontoidea.
of—occipital foramen.
ol—oculata.
p—pedicel.
pa—postgena.
pf—palpifer.
pn—pretentorina.
pox—postpharynx.
pp—palpiger.
pr—precoila.
pt—pretentorium.
ptc—postartis.
ptl—postcoila.
py—preartis.
rt—rectotendon.
s—stipes.
sc—scape.
sld—salivary duct.
sm—submentum.
so—salivos.
st—supratentorium.
v—vertex.

EXPLANATION OF PLATES.

PLATE XXV.

Fig. 1. *Panorpodes oregonensis*, cephalic aspect of head.
Fig. 2. *Bittacus strigosus*, cephalic aspect of sinistral mandible.
Fig. 3. *Bittacus strigosus*, cephalic aspect of head.
Fig. 4. *Boreus nivoriundus*, caudal aspect of sinistral mandible.
Fig. 5. *Apterobittacus apterus*, cephalic aspect of head.
Fig. 6. *Apterobittacus apterus*, cephalic aspect of sinistral mandible.
Fig. 7. *Merope tuber*, cephalic aspect of head.
Fig. 8. *Bittacus strigosus*, caudal aspect of sinistral mandible.
Fig. 9. *Merope tuber*, cephalic aspect of sinistral mandible.

Fig. 10. *Panorpa americana*, cephalic aspect of head.
Fig. 11. *Boreus nivoriundus*, cephalic aspect of sinistral mandible.
Fig. 12. *Panorpa americana*, caudal aspect of sinistral mandible.
Fig. 13. *Panorpa americana*, cephalic aspect of sinistral mandible.
Fig. 14. *Boreus nivoriundus*, cephalic aspect of head.
Fig. 15. *Panorpodes carolinensis*, cephalic aspect of sinistral mandible.
Fig. 16. *Apterobittacus apterus*, caudal aspect of sinistral mandible.
Fig. 17. *Panorpodes oregonensis*, caudal aspect of head.
Fig. 18. *Merope tuber*, caudal aspect of sinistral mandible.
Fig. 19. *Bittacus strigosus*, caudal aspect of head.
Fig. 20. *Panorpodes oregonensis*, caudal aspect of sinistral mandible.
Fig. 21. *Panorpodes oregonensis*, cephalic aspect of sinistral mandible.
Fig. 22. *Apterobittacus apterus*, caudal aspect of head.
Fig. 23. *Panorpodes carolinensis*, caudal aspect of sinistral mandible.

PLATE XXVI.

Fig. 24. *Panorpa americana*, caudal aspect of head.
Fig. 25. *Merope tuber*, caudal aspect of head.
Fig. 26. *Boreus nivoriundus*, caudal aspect of head.
Fig. 27. *Panorpodes oregonensis*, lateral aspect of head.
Fig. 28. *Bittacus strigosus*, lateral aspect of head.
Fig. 29. *Apterobittacus apterus*, lateral aspect of head.
Fig. 30. *Merope tuber*, lateral aspect of head.
Fig. 31. *Panorpa americana*, lateral aspect of head.
Fig. 32. *Boreus nivoriundus*, lateral aspect of head.

PLATE XXVII.

Fig. 33. *Bittacus strigosus*, antenna
Fig. 34. *Merope tuber*, antenna.
Fig. 35. *Boreus nivoriundus*, antenna.
Fig. 36. *Boreus nivoriundus*, labium and maxillæ.
Fig. 37. *Panorpodes oregonensis*, ental portion of tentorium.
Fig. 38. *Panorpodes oregonensis*, lateral view of tentorium.
Fig. 39. *Panorpodes oregonensis*, caudal aspect of tentorium.
Fig. 40. *Bittacus strigosus*, lateral view of tentorium.
Fig. 41. *Bittacus strigosus*, maxilla.
Fig. 42. *Panorpa americana*. cephalic aspect of galea.
Fig. 43. *Bittacus strigosus*, cephalic aspect of galea.
Fig. 44. *Apterobittacus apterus*, labium and maxillæ.
Fig. 45. *Panorpodes carolinensis*, labium and maxillæ.
Fig. 46. *Merope tuber*, labium and maxillæ.
Fig. 47. *Panorpa americana*, maxilla.
Fig. 48. *Panorpa americana*, labium and maxillæ.
Fig. 49. *Panorpodes oregonensis*, labium and maxillæ.

PLATE XXVIII.

Fig. 50. *Panorpodes oregonensis*, epipharynx.
Fig. 51. *Panorpa americana*, diagrammatic section to show hypopharynx, salivos and salivary duct.
Fig. 52. *Bittacus strigosus*, epipharynx, hypopharynx and mandible.
Fig. 53. *Apterobittacus apterus*, hypopharynx and salivary duct.
Fig. 54. *Merope tuber*, hypopharynx and salivary duct.
Fig. 55. *Merope tuber*, lateral view of galea.
Fig. 56. *Panorpa americana*, caudal aspect of head, to show mandibles, tendons and postpharynx.
Fig. 57. *Bittacus strigosus*, mecaglossa and palpi folded back to show hypopharynx and salivos.
Fig. 58. *Panorpodes oregonensis*, hypopharynx and salivary duct.
Fig. 59. *Merope tuber*, epipharynx and mandible.
Fig. 60. *Boreus nivoriundus*, hypopharynx.
Fig. 61. *Panorpa americana*, epipharynx, hypopharynx, salivos.